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DeSantis

[11] **4,362,483**

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[54] **HYDRAULIC SHOCK ABSORBING MECHANISM FOR THE RAM OF POWDER COMPACTING PRESSES AND THE LIKE**

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[52] **U.S. Cl.** **425/78**; 425/214; 425/412

[58] **Field of Search** 425/78, 412, 444, 193, 425/214

[56] **References Cited**

U.S. PATENT DOCUMENTS

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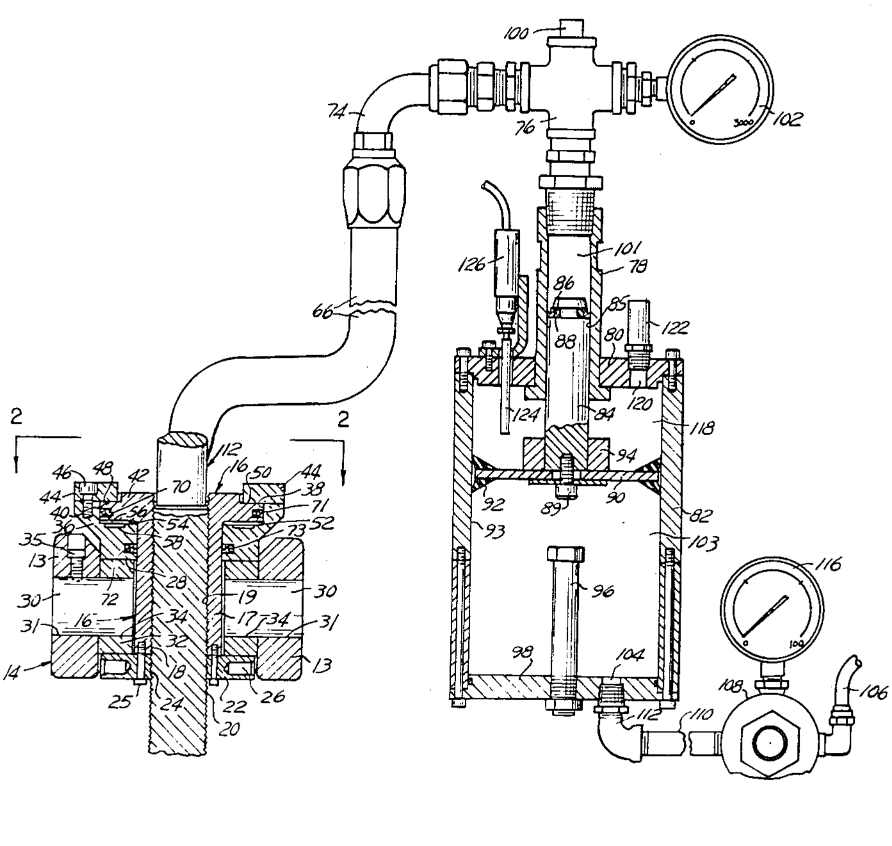
3,524,220	8/1970	Davison	425/78
3,561,056	2/1971	Smith et al.	425/78
3,657,917	4/1972	Chelminski	425/78 X
3,669,582	6/1972	Smith	425/78
3,733,154	5/1973	Smith et al.	425/78
3,741,697	6/1973	Smith et al.	425/444 X

Primary Examiner—J. Howard Flint, Jr.
Attorney, Agent, or Firm—Hauke & Patalidis

[57] **ABSTRACT**

An impact cushioning and shock absorbing device disposed in the coupling between the actuating member of a press ram and the ram. The device is in the form of a hydraulic piston-cylinder assembly defining a chamber which is filled with an uncompressible hydraulic fluid. The hydraulic fluid is pressurized by a compressed compressible fluid, such as air, acting on a large area piston directly coupled to a small area piston disposed in a small diameter cylinder filled with the incompressible hydraulic fluid and in communication with the chamber, the ratio in the areas of the pistons determining the pressure amplification rate or gain. When the press ram meets a resistance to its travel which is large enough to overcome the pressure of the hydraulic fluid in the chamber, the volume of the chamber is decreased with the result that hydraulic fluid is introduced in the small diameter cylinder, thus displacing the small area and the large area pistons against the pressure of the compressible fluid, and cushioning the impacts and shocks to which the ram is subjected in operation.

10 Claims, 3 Drawing Figures



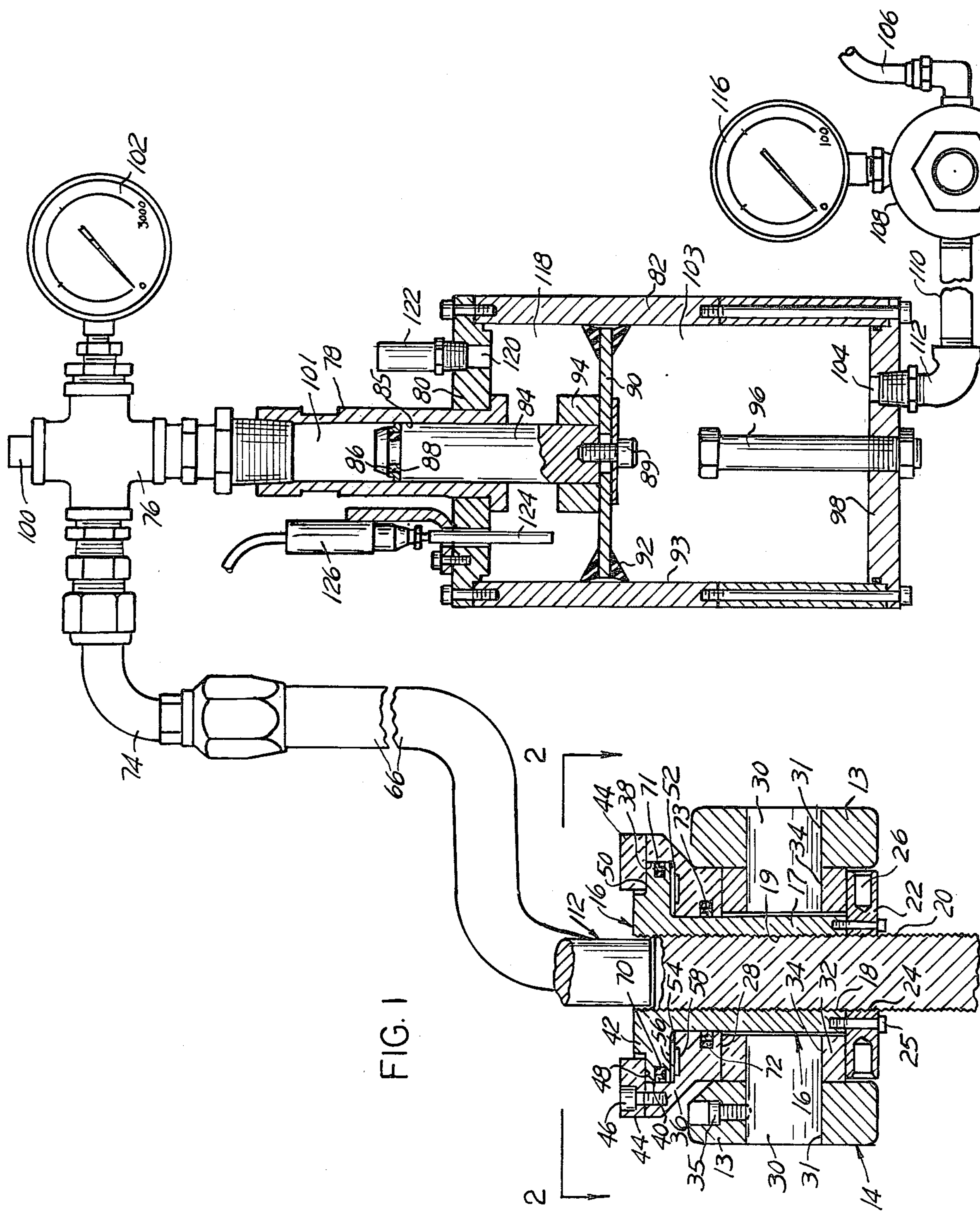

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FIG. 1

FIG.2

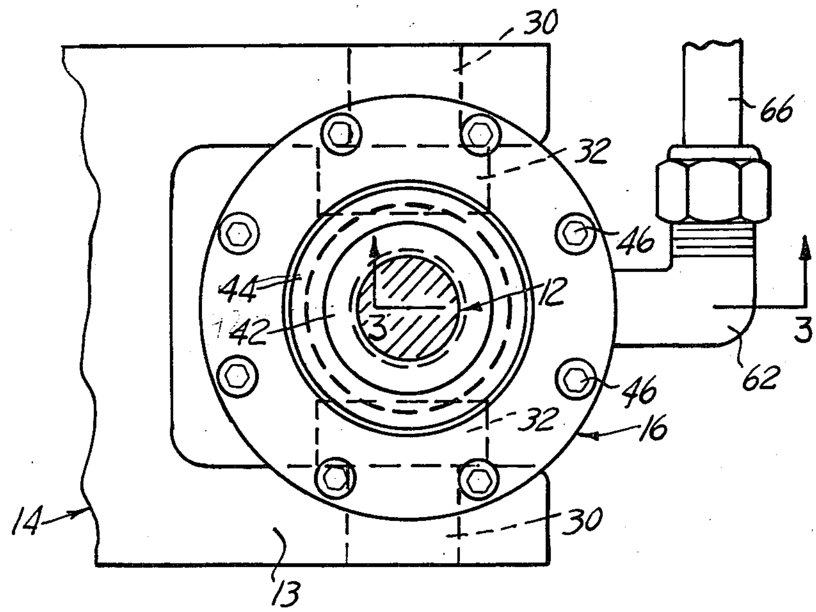
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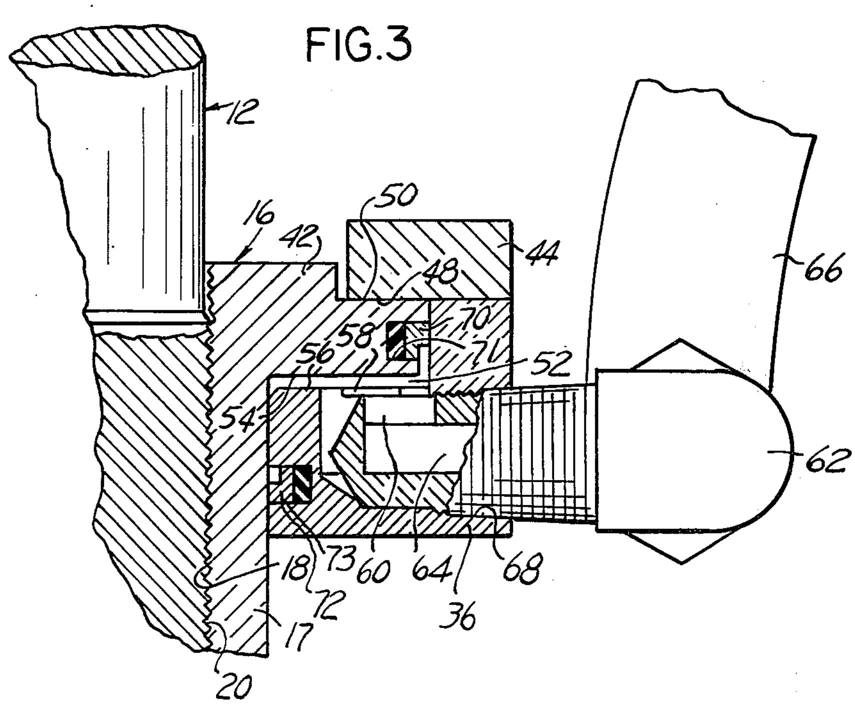
FIG.3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HYDRAULIC SHOCK ABSORBING MECHANISM FOR THE RAM OF POWDER COMPACTING PRESSES AND THE LIKE

BACKGROUND OF THE INVENTION

In precision press operations, more particularly when articles compacted of powder material are subject to tight tolerance and high precision, dimensionally as well as in density of the compacted articles, it is advantageous to provide some mechanism for relieving the initial press force by which the compacting is accomplished and for cushioning the impact shocks. Various types of deflection compensation systems and impact shock cushioning devices have been proposed in the past, such as disclosed in U.S. Pat. No. 3,733,154, assigned to the same assignee as the present invention, which discloses an impact shock or absorbing system forming part of the press ram itself. Deflection compensation and shock absorbing mechanisms may also be incorporated into the die and punch assembly, as disclosed, for example, in U.S. Pat. No. 3,669,582, also assigned to the same assignee as the present application.

SUMMARY OF THE INVENTION

In addition, it is often desirable to effectuate a pressing operation at a predetermined ram pressure or at ram pressure within a predetermined range of pressures. Such a requirement is difficult to achieve in a mechanical press.

The present invention provides an impact cushioning and shock absorbing mechanism and a ram pressure adjusting device, more particularly for the ram of a powder compacting press, which requires no modification to the ram itself or to the punch and die assembly used for forming workpieces. The invention provides an impact cushioning, shock absorbing and pressure adjusting mechanism forming part of the coupling member between the ram of a press and the actuating member for reciprocating the ram, and the invention may thus be incorporated as part of the press mechanism during manufacture or installed in retrofitting already existing presses presently in operation.

The diverse objects and advantages of the present invention will become apparent to those skilled in the art when the following description of the best mode contemplated for practicing the invention is read in conjunction with the accompanying drawing wherein:

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 illustrates, with some portions omitted and others broken away, an example of structure for impact cushioning and shock absorbing means for the ram of a press such as a treadle-actuated ram for powder compacting press;

FIG. 2 is a partial top plan view from line 2—2 of FIG. 1; and

FIG. 3 is a partial sectional view from line 3—3 of FIG. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In U.S. Pat. Nos. 3,328,840, 3,328,842, 3,415,142, 3,561,056 and 3,741,697, for example, there are disclosed powder compacting presses having a ram, such as ram **12** as illustrated in the drawing, reciprocated as a result of being driven by the bifurcated end **13** of a rocker arm or treadle **14** through the intermediary of a spool **16**. The ram **12** is supported for reciprocation below the table of the press, not shown, and punch holding means, not shown, are mounted on the end of the ram **12** for reciprocating the punch or punches of a punch and die assembly mounted in an aperture in the table.

The spool **16** has a body **17** having a longitudinal bore **18** provided with an internal thread **19** engaging a corresponding peripheral threaded portion **20** of the ram **12**. The spool **16** has a lower radially extending flange formed by a disk-like plate **22**, also provided with an internally threaded bore **24** mounted on the lower end of the spool body **17**, appropriate screws or bolts **25** fastening the disk-plate **22** to the end of the spool body **17**. Radial bores are disposed in the flange plate **22**, as shown at **26** at FIG. **1**, such that by means of a spanner or a rod introduced through a bore **26**, the flange plate **22** and the spool body **17** are rotated in unison to adjust the relative position of the spool **16** along the longitudinal axis of the ram **12**. As is well known in the art, the upper limit of the adjustment of the spool **16** along the longitudinal axis of the ram **12** determine the press dwell position of the compacting punches.

The force of compaction is transmitted through the ram **12** to the article to be compacted by the oscillating bifurcated end **13** of the treadle **14** via an upper annular abutment **28** of the spool **16**. In prior art structures as disclosed in the aforesaid patents, the annular abutment **28** is on a flange which is an integral part of the spool **16**, and the force of compaction is transmitted to the spool **16** through the intermediary of a pair of pins **30** mounted in aligned bores **31** in the bifurcated end **13** of the treadle **14** and of a pair of substantially rectangular pillar blocks **32**, each having a central bore **34** through which is disposed the end of each pin **30**. Set screws, such as set screws **35**, hold each pin **30** fast in each bore **31**.

In the structure illustrated in the drawing however, the annular abutment surface **28** is formed at the bottom of a ring or sleeve **36** slidably disposed around the periphery of the body **17** of the spool **16**. The sleeve **36** has an enlarged diameter bore **38** slidably accepting the edge portion **40** of a flange **42** integrally formed on the end of the spool body **17**. The permissible displacement of the sleeve **36** relative to the flange **42** of the spool body **17** is limited in one direction by a ring **44**, fastened to the top of the sleeve **36** by means such as bolts or screws **46**, as a result of the engagement of an annular abutment surface **48** on the ring **44** with a corresponding annular abutment surface **50** on the top of the spool flange **42**. When the two annular surfaces **48** and **50** abut, a variable volume changer in the form of an annular chamber **52** is formed between the lower annular surface **54** of the spool flange **42** and an annular surface **56** disposed at the bottom of the enlarged diameter bore **38** in the sleeve **36**. The annular chamber **52** is placed in fluid communication, by means of an annular groove **58** formed in the annular surface **56** with a passageway **60**, FIG. **3**, transversely disposed at the end of a fitting **62** and leading into a channel **64** in the fitting **62** mounted on the end of a flexible hose **66**. The fitting **62** is fitted into a radial threaded aperture **68** in the sleeve **36**. Seals in the form of annular rings **70** and **72** are disposed in appropriate grooves **71** and **73** respectively in the edge **40** of the spool flange **42** and in the inner surface of the sleeve **36** engaged with the peripheral surface of the spool body **17** to prevent flow of fluid from the annular chamber **52**, except through the fitting **62** and hose **66**, when the volume of the annular chamber **52** is reduced as a result of the sleeve **36** being displaced relative to the spool flange **42** in the direction that disengages the annular abutment surfaces **48** and **50** from each other.

The flexible hose **66** is connected through an elbow **74**, FIG. **1**, and a T-connector **76**, for example, to a relatively small bore cylinder **78** fastened in the end wall **80** of a much larger bore cylinder **82**. A piston rod **84** is mounted reciprocable in the bore **85** of the cylinder **78**, the end of the piston rod **84** being provided with an appropriate sealing ring **86** fitted in a receiving groove **88**. The other end of the piston rod **84** is fastened, such as by a bolt **89**, to a relatively large piston **90**, provided with peripheral elastomeric piston cup **92**, disposed reciprocable in the relatively large bore **93** of cylinder **82**. The upward displacement of the piston **90** is limited by a ring **94** disposed around the piston rod **84** at its junction with the piston **90**, and the permissible travel of the piston **90**, in a downward direction, is limited by an axially fastened stud or bolt **96** projecting in the interior of the cylinder **82** from the other end wall **98** of the cylinder.

The T-connector **76**, which is the highest point of the system, is provided with a plug **100** closing the top of the T-connector such that, after removal of the plug **100**, the chamber **101** defined in the bore **85** of the cylinder **78** above the end of the piston rod **84** and the whole system including the annular chamber **52**, and the flexible hose **66**, may be filled with an uncompressible hydraulic fluid such as oil. The pressure of the hydraulic fluid in the system is visually displayed by a pressure gauge **102**.

Compressed air may be introduced into a chamber **103** in the bore **93** of the cylinder **82** below the piston **90** through a port **104** in the cylinder end wall **98**. Compressed air is obtained from an air compressor or other compressed air source, not shown, through a line **106**, a pressure regulator **108** and a line **110** connected to a fitting **112** providing air to the chamber **103** through the port **104**. A pressure gauge **116** displays the pressure of the air being supplied to the chamber **103**, as adjusted by means of the reguator **108**. In view of the difference in areas between the piston **90** and the piston rod **84**, the assembly of the piston **90** and piston rod **84** displaceable in the cylinder **82** and the cylinder **78** acts as a pressure amplifier between the air contained in the chamber **103** and the oil contained in the chamber **101** above the piston rod **84**, the gain or amplification factor of the pressure amplifier being proportional to the ratio of the surface area of the piston **90** to the surface area of the piston formed at the end of the rod **84**. Atmospheric air present in the chamber **118** formed on the top of the piston **90** between the piston and the end wall **80** of the cylinder **82** is exhausted to the ambient through a port **120** provided with a muffler **122**. In the event of complete loss of pressure of the fluid in the hydraulic fluid portion of the system, the piston **90** is caused by the air pressure in the chamber **103** to be displaced upwardly until the upper surface of the piston engages the end of a plunger **124** tripping a safety electric limit switch **126** from "on" to "off". The limit switch **126**, when turned off, in turn turns off the relay of the press motor, such as to immediately stop the operation of the press.

In operation, compressed air at a predetermined pressure is supplied to the chamber **103** in the bore **93** of the cylinder **82** below the piston **90**. The incompressible hydraulic fluid, such as oil, filling the annular chamber **52** holds apart the annular surface **56** of the sleeve **36** and the annular surface **54** of the spool flange **42**, the annular surfaces **48** and **50** being in engagement with each other as illustrated in the drawing. At the end of a compaction cycle, that is at the end of the upper stroke of the ram **12** as actuated by the treadle **14** through the sleeve **36**, if the pressure applied to the article being compacted exceeds the force exerted on the spool **16** by the pressure of the oil in the annular chamber **52**, oil is expelled from the annular chamber **52**, thus displacing the piston rod **84** downwardly against the air pressure in the chamber **103** below the piston **90**. The system, therefore, acts as a cushion which dampens mechanical shocks, and by correct adjustment of the pressure of the compressible fluid, such as compressed air, in the system the pressure exerted by the punches on the article being compacted may be precisely determined as a function of the pressure in the system, rather than as a function of the dwell position of mechanical parts having solid surfaces in engagement.

A particular advantage of the invention which will be readily apparent to those skilled in the art is that the invention permits to effectuate compaction of articles repetitively at a constant predetermined ram pressure. For that purpose, the chamber **103** in the bore **93** of the cylinder **82** below the piston **90** is filled with compressed air at a predetermined pressure, as controlled by the setting of the pressure regulator **108**. The regulator **108** is set such as to maintain the pressure in the chamber **103** constant, with the result that the pressure of the hydraulic fluid in the chamber **101** above the piston rod **84** and in the variable volume annular chamber **52** is maintained at a constant value. The stroke of the ram **12** is adjusted such that when the ram **12** dwells at the end of its compacting stroke the annular flange **42** of the spool **16** is caused to be displaced relatively to the sleeve **36** from the position illustrated at FIG. **1** to any intermediary position short of causing engagement of the annular surface **54** with the annular surface **56**. This in turn causes a reduction of the volume of the variable volume annular chamber **52**, thus pumping a portion of the incompressible hydraulic fluid contained in the chamber **52** into the high pressure hydraulic system. As the pressure of the hydraulic system remains constant, pressing of the compacted article is effected at constant pressure.

If it is desired to compact articles at a pressure within a predetermined range, the air pressure regulator **108** is adjusted such that after compressed air at a predetermined pressure has been introduced in the chamber **103**, backflow of compressed air through the pressure regulator is prevented even though the pressure of the air in the chamber **103** may have been increased. Under those conditions when, during dwell of the ram **12** at the end of its pressing stroke, the volume of the annular chamber **52** is momentarily decreased, the downward displacement of the piston **90** in the cylinder **82** causes an increase of pressure of the compressed air in the chamber **103** below the piston, and consequently an increase of the pressure in the high pressure hydraulic portion of the system.

If the resisting force to which the ram **12** is subjected exceeds the force provided by the pressurized fluid contained in the annular chamber **52**, the spool annular flange **42** is caused to be displaced relative to the sleeve **36**, until the annular surfaces **54** and **56** engage each other. Under those conditions, the ram function is exactly the same as it would be, except for a slight lost motion, in a mechanical press without the benefit of the improvement of the invention.

It will be appreciated by those skilled in the art that structures other than the one described hereinbefore in detail may be used for providing a variable volume chamber interposed between a press ram and the ram actuating mechanism, such as a chamber having deformable end diaphragms or a chamber in the form of an expandable bag, for example.

Having thus described the invention by way of an example of structure thereof, modifications whereof will be apparent to those skilled in the art, what is claimed as new is as follows:

1. In a press apparatus having a reciprocable ram, means for reciprocating said ram and means coupling said reciprocating means to said ram, an impact cushioning and shock absorbing device for said coupling means comprising a first intermediary member attached to said ram, a second intermediary member displaceable relative to said first intermediary member, a pair of abutment means each on one of said intermediary members limiting the travel of said first intermediary member away from said second intermediary member, means connecting said reciprocating means to said second intermediary member, a variable volume chamber between said intermediary members, means for introducing a non-compressible fluid in said variable volume chamber for normally holding said intermediary members away from each other and for holding said abutment means in engagement with each other, and means connected to said introducing means for pressurizing said noncompressible fluid, said pressurizing means comprising a first cylinder, a first piston reciprocably disposed in said first cylinder, means for introducing a compressible fluid on one side of said first piston, a rod attached to said first piston and reciprocable thereby, a second cylinder, a second piston disposed on the end of said rod and reciprocable in said second cylinder for pressurizing said noncompressible fluid in said second cylinder, wherein said first piston has an area relatively larger than the area of said second piston for transmitting the pressure of said compressible fluid to said noncompressible fluid with an amplification which is proportional to the ratio of the areas of the pistons.

2. The device of claim **1** wherein said variable volume chamber is defined by said intermediary members forming a piston-cylinder arrangement.

3. The device of claim **1** further comprising limit switch means tripped by said first piston upon travel beyond a limit, sid limit switch being arranged to interrupt the operation of said press apparatus.

4. The device of claim **2** wherein said reciprocating means comprises the bifurcated end of a power driven oscillating treadle and said coupling means comprises a spool member threadably mounted around said ram, said spool member having an annular flange defining said first intermediary member, a sleeve member disposed around said spool member and defining said second intermediary member, said sleeve member having a bore accepting said flange, said flange forming said piston and said sleeve member forming said cylinder of said piston-cylinder arrangement.

5. The device of claim **4** wherein said abutment means comprises a ring fastened to said sleeve member and an annular surface on said flange engageable with said ring.

6. The device of claim **5** further comprising means limiting the displacement of said first piston in at least one direction.

7. The device of claim **6** comprising means limiting the displacement of said first piston in both directions.

8. The device of claim **7** wherein said second piston is said rod.

9. The device of claim **1** wherein the pressure of said compressible fluid is maintained constant.

10. The device of claim **1** wherein the pressure of said compressible fluid is maintained within a defined range.

* * * * *